

K.N.Toosi
Universit of technology
Control dep.

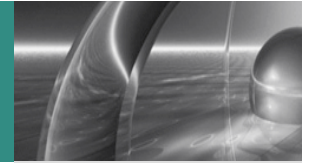


Ali Alizadeh Kashani

Flow Measurement

Instrumentation Course
Dr. Taghirad

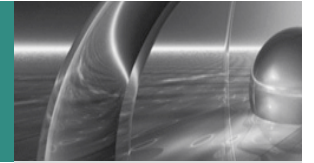
HeadLines:



- 1 Basic Definitions
- 2 Methods
- 3 Key Features to Design
- 4 Market



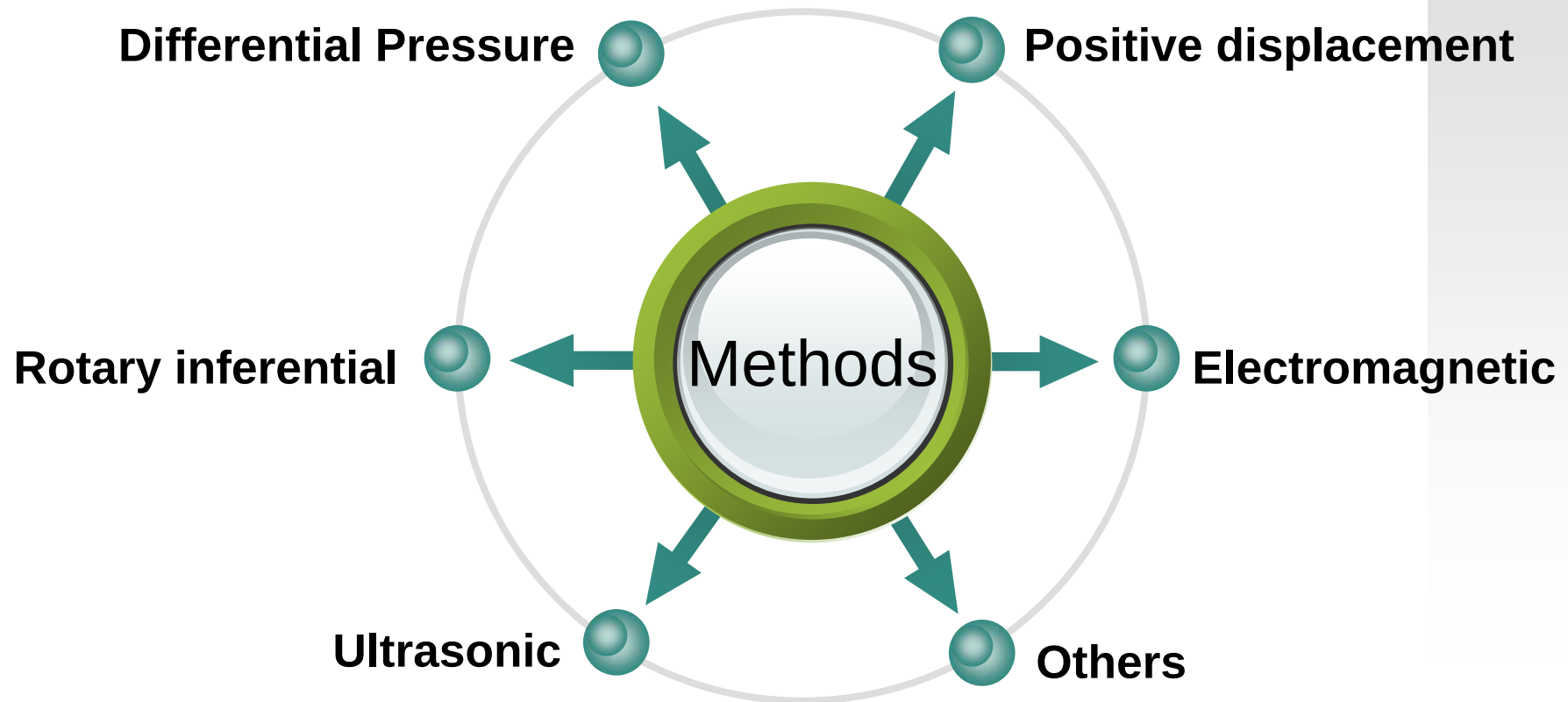
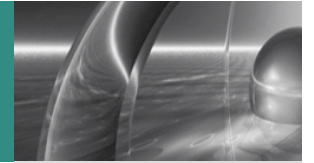
Basic Definitions



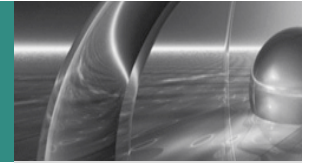
- ❖ **Mass flow rate**
- ❖ **Volumetric flow rate**
- ❖ **Bernoulli's principle**
- ❖ **Dynamic pressure**
- ❖ **Reynolds Number**



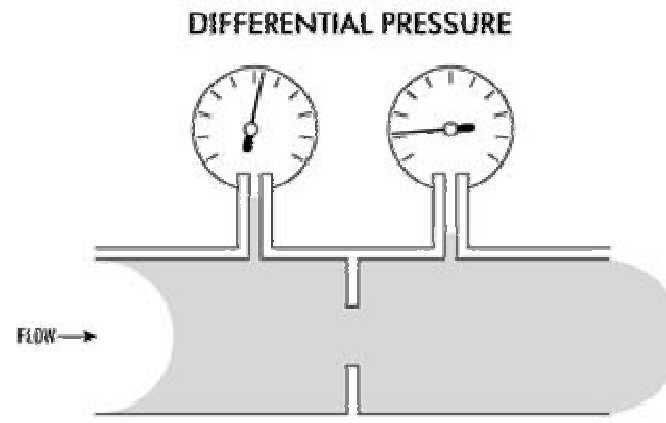
Methods



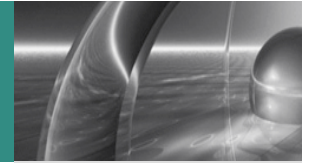
Differential Pressure Measurement



- ❖ Differential pressure flow meters use Bernoulli's equation to measure the flow of fluid in a pipe. Differential pressure flow meters introduce a constriction in the pipe that creates a pressure drop. When the flow increases, more pressure drop is created. Bernoulli's equation states that the pressure drop across the constriction is proportional to the square of the flow rate. Impulse piping route the upstream and downstream pressures to the electronic transmitter that measures the differential pressure to determine the fluid flow.



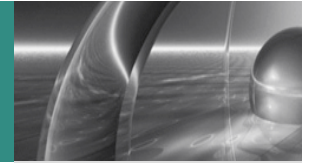
Differential Pressure Measurement



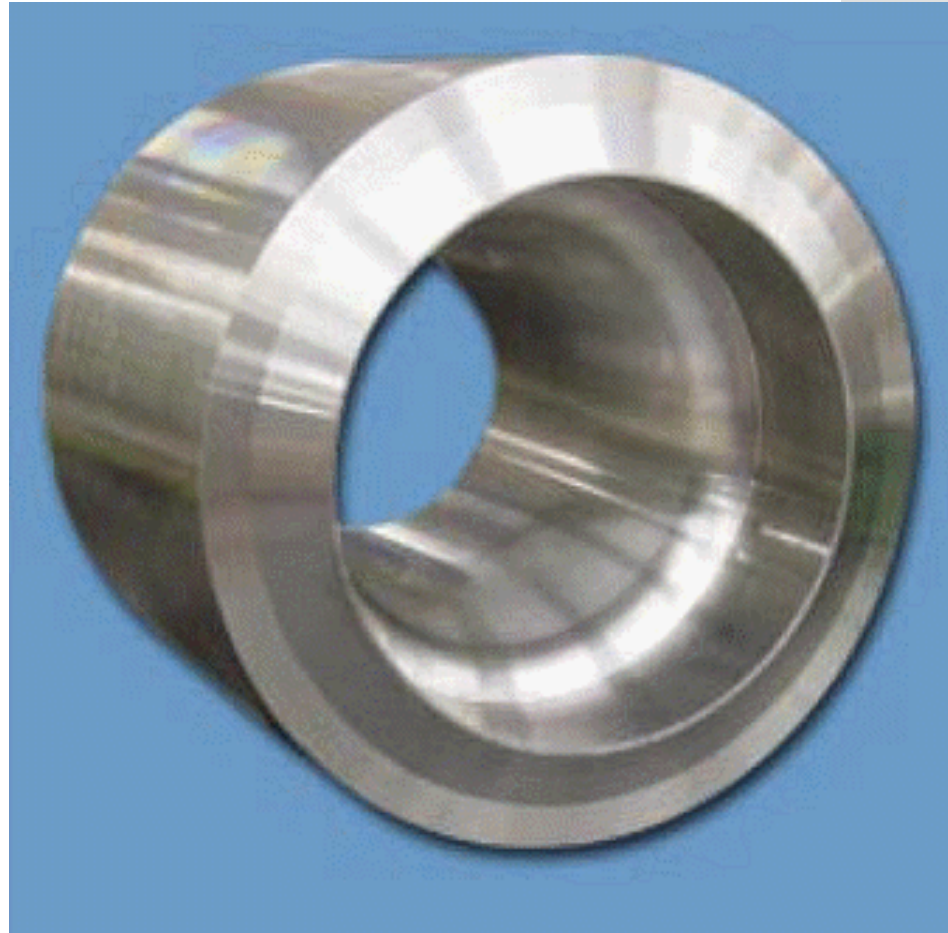
- **Orifice Plate**



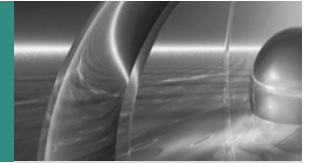
Differential Pressure Measurement



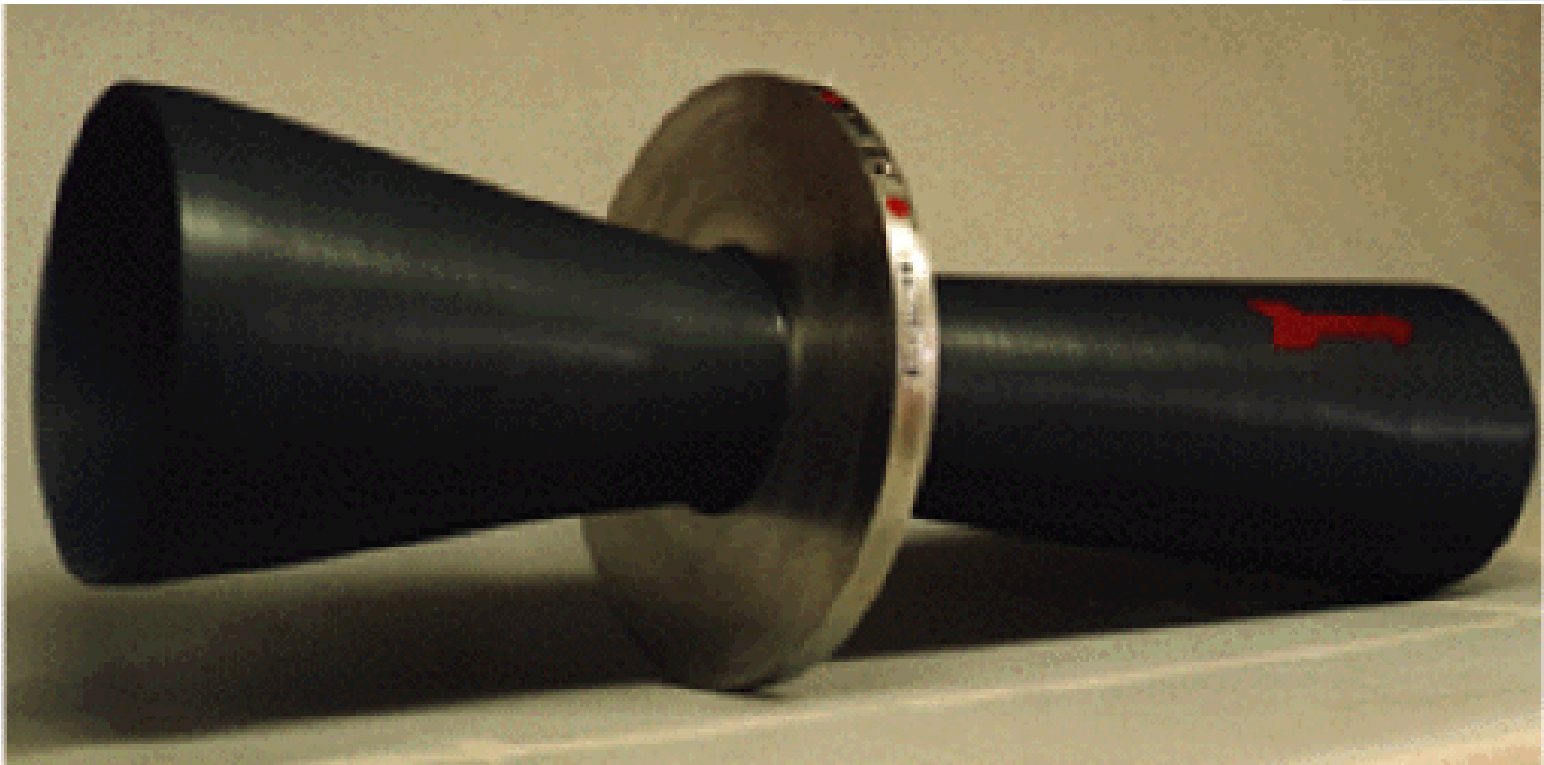
❖ Flow Nozzle



Differential Pressure Measurement

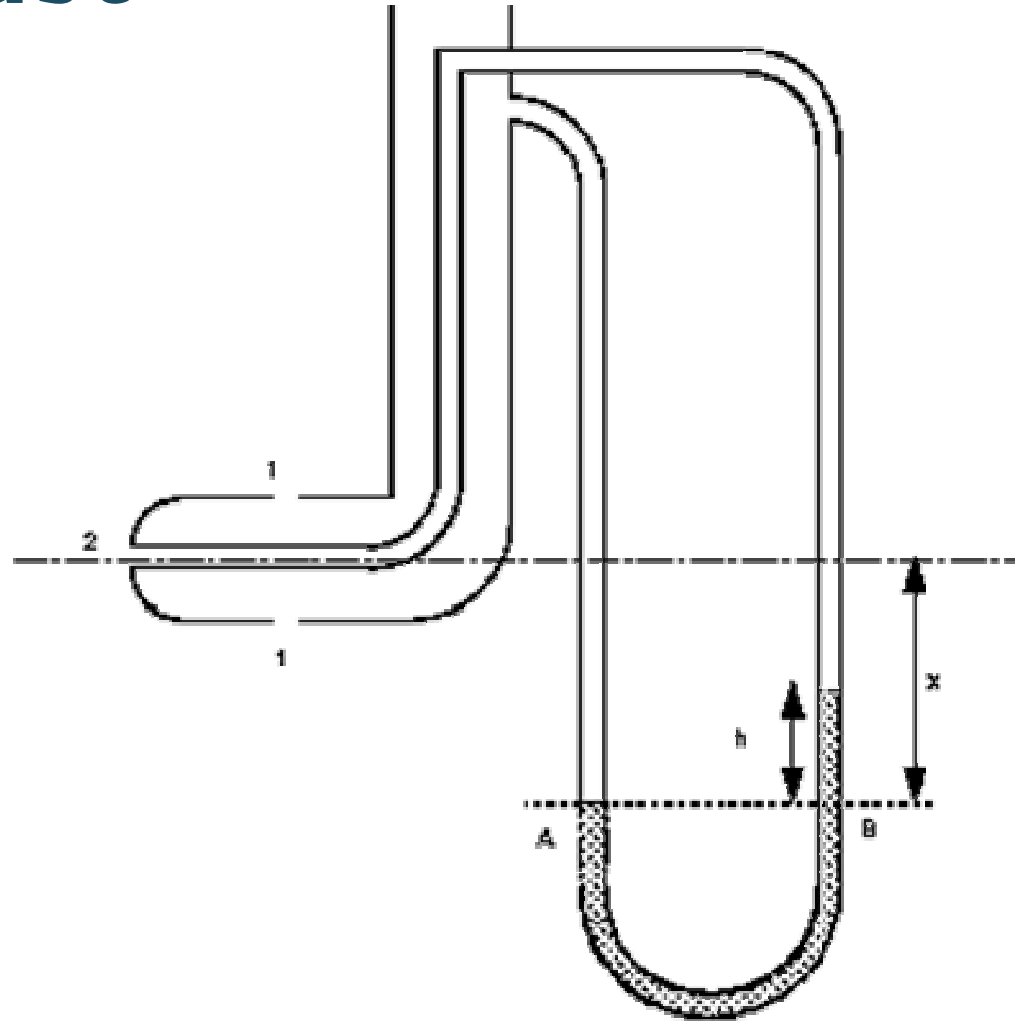


❖ Venturi Tube



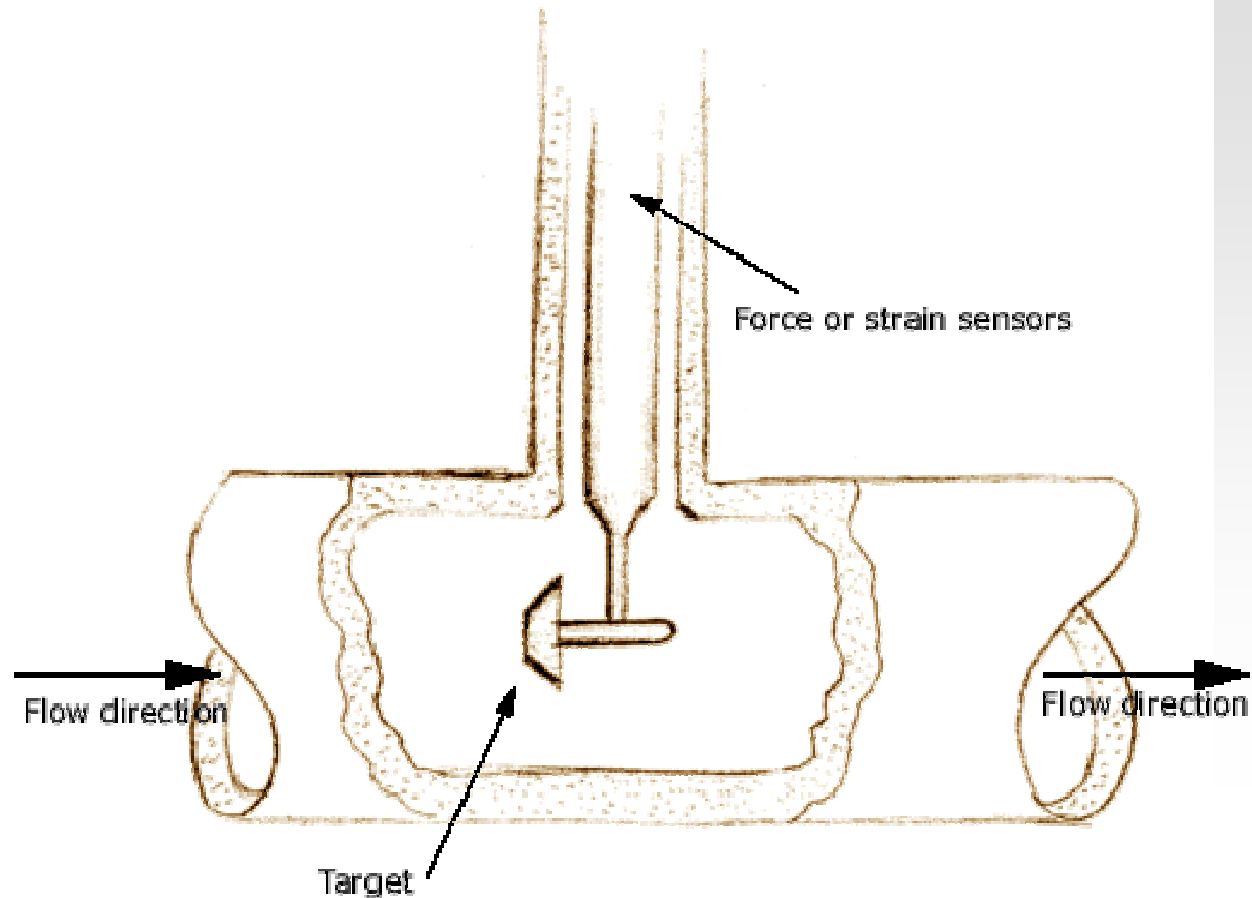
Differential Pressure Measurement

■ Pitot Tube



Differential Pressure Measurement

❖ Target Flow Meter



Target flowmeter places a target into the flow pass and measures the force applied by the passing fluid to calculate the volume flow rate.



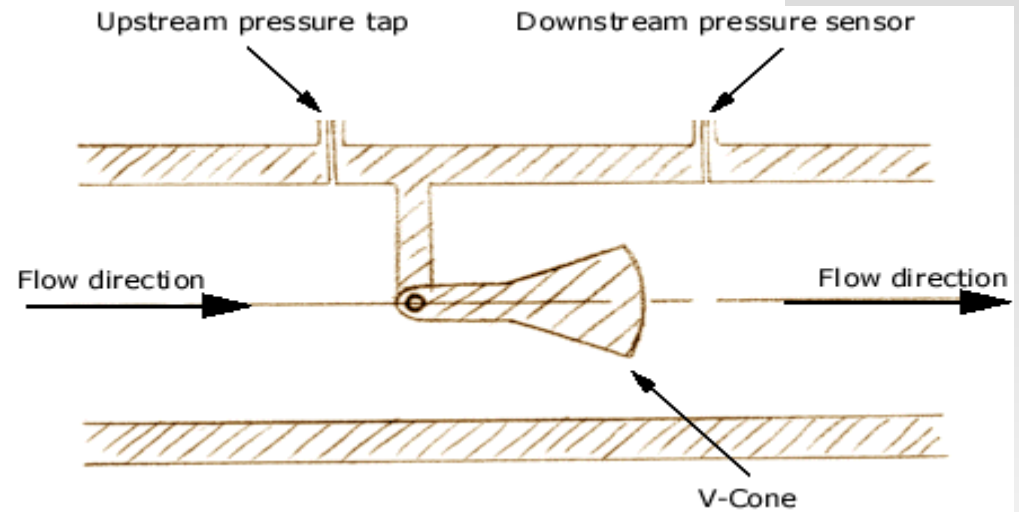
Differential Pressure Measurement

❖ Segmental Wedge



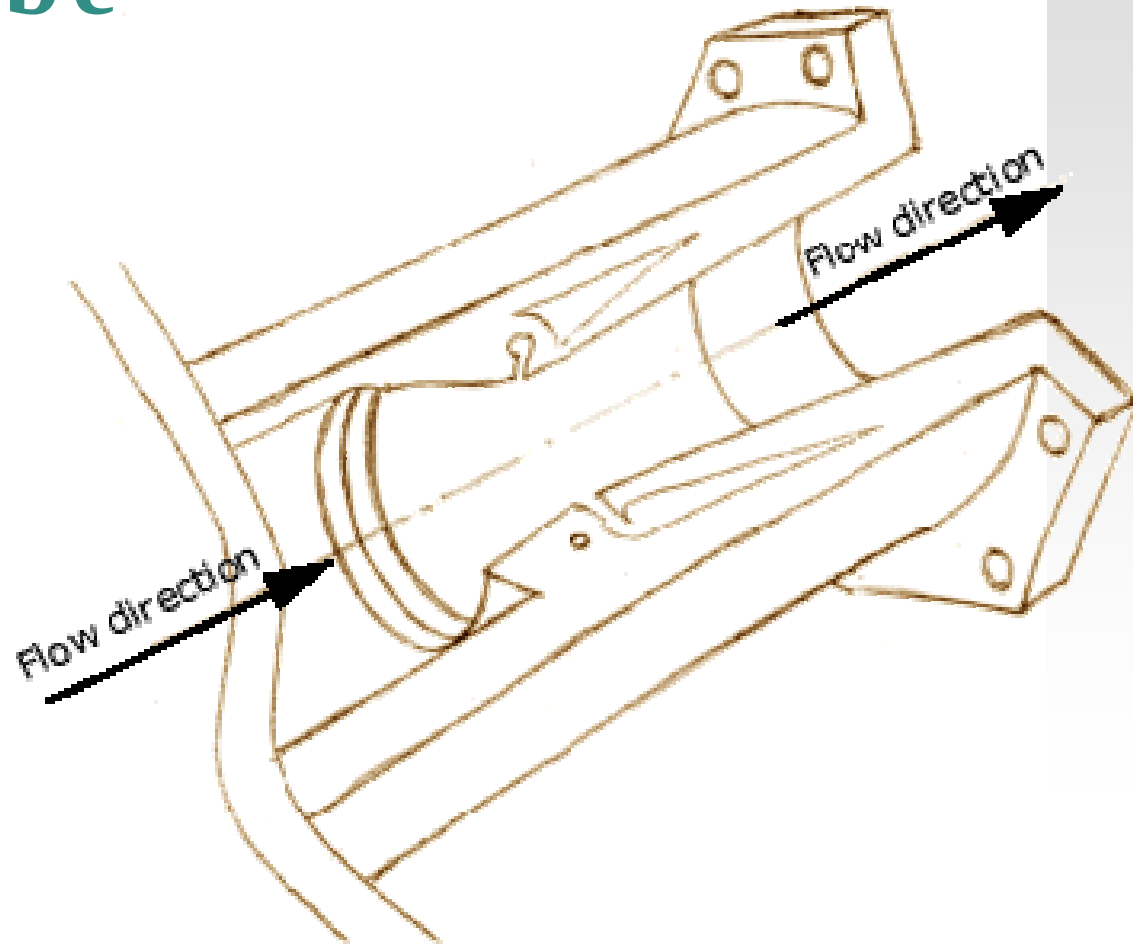
Differential Pressure Measurement

■ V-Cone



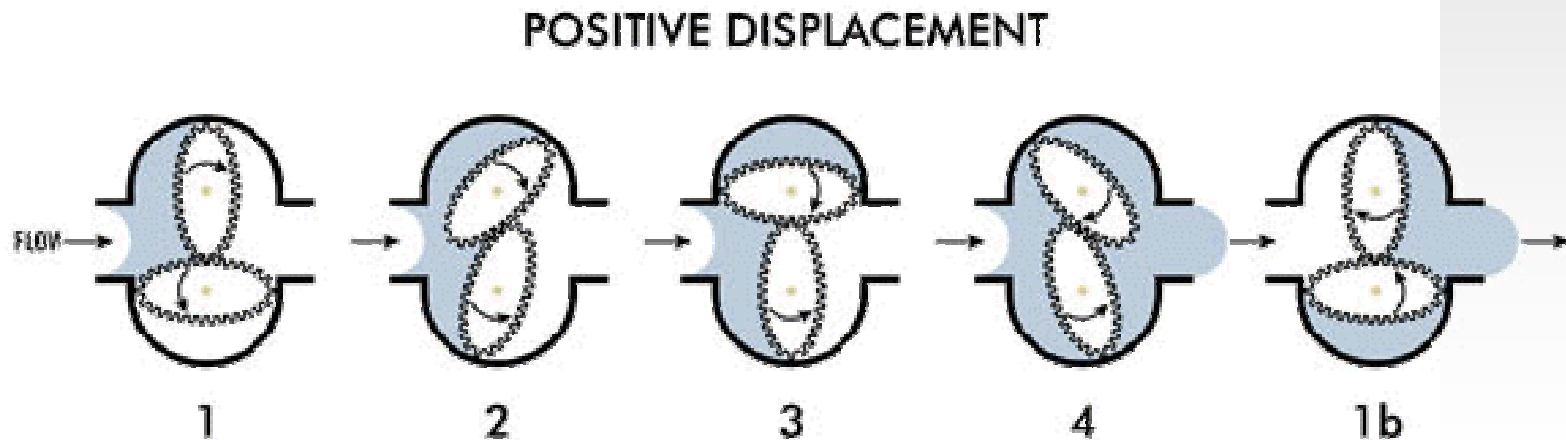
Differential Pressure Measurement

❖ Dall Tube

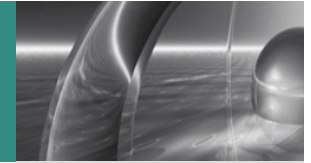


Positive Displacement

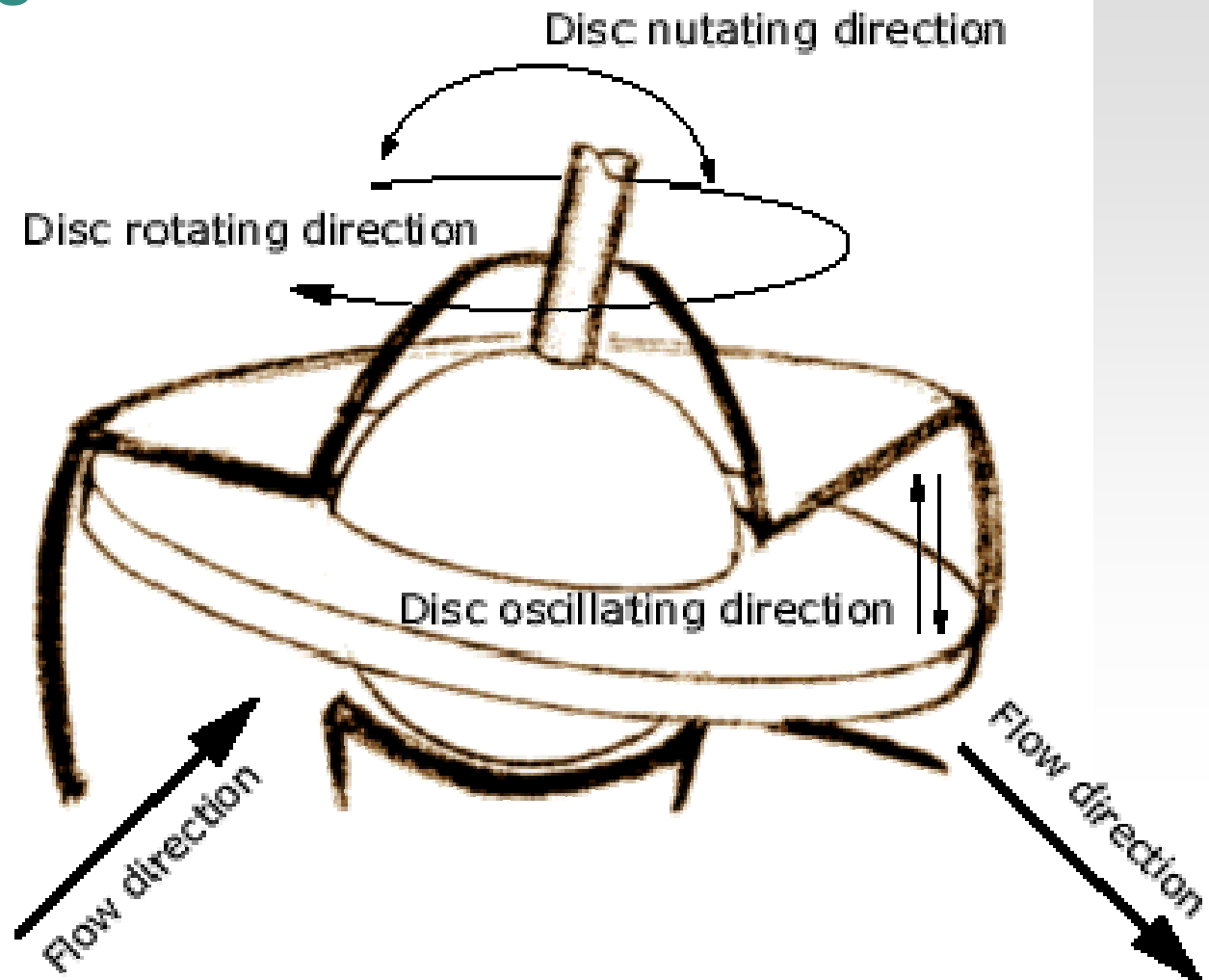
- ❖ Positive displacement flow meters, also known as PD meters, measure volumes of fluid flowing through by counting repeatedly the filling and discharging of known fixed volumes.



Positive Displacement



❖ Nutating Disc



Positive Displacement

❖ Oscillating Piston

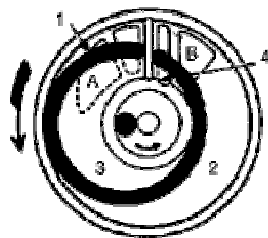


DIAGRAM 1
SPACES 1 AND 3 ARE RECEIVING LIQUID FROM THE INLET PORT, A, AND SPACES 2 AND 4 ARE DISCHARGING THROUGH THE OUTLET PORT, B.

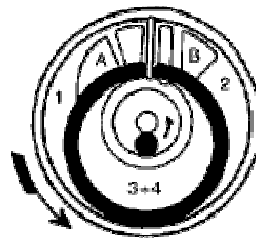


DIAGRAM 2
THE PISTON HAS ADVANCED AND SPACE 1, IN CONNECTION WITH THE INLET PORT, HAS ENLARGED, AND SPACE 2, IN CONNECTION WITH THE OUTLET PORT, HAS DECREASED, WHILE SPACES 3 AND 4, WHICH HAVE COMBINED, ARE ABOUT TO MOVE INTO POSITION TO DISCHARGE THROUGH THE OUTLET PORT.

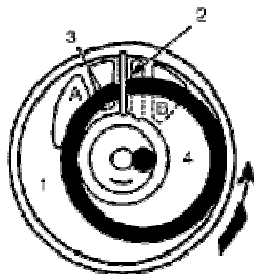


DIAGRAM 3
SPACE 1 IS STILL ADMITTING LIQUID FROM THE INLET PORT AND SPACE 3 IS JUST OPENING UP AGAIN TO THE INLET PORT, WHILE SPACES 2 AND 4 ARE DISCHARGING THROUGH THE OUTLET PORT.

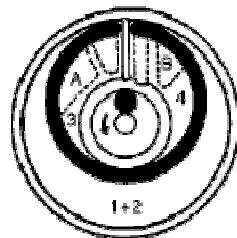
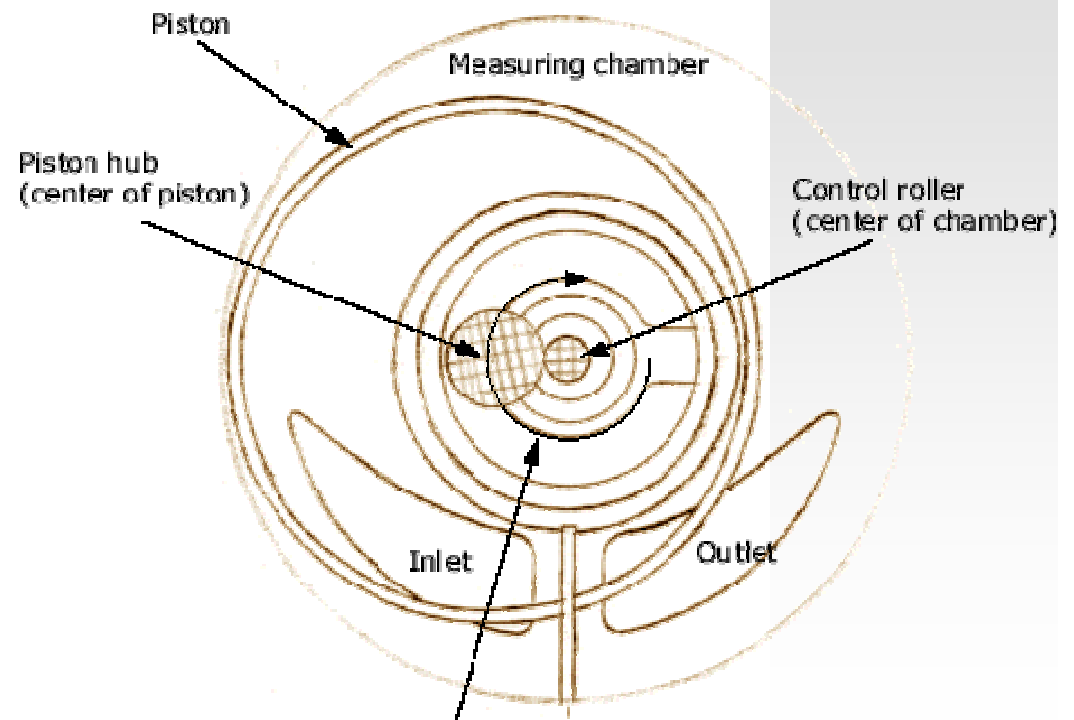


DIAGRAM 4
LIQUID IS BEING RECEIVED INTO SPACE 3 AND DISCHARGED FROM SPACE 4, WHILE SPACES 1 AND 2 HAVE COMBINED AND ARE ABOUT TO BEGIN DISCHARGING AS PISTON MOVES FORWARD AGAIN TO OCCUPY POSITION AS SHOWN IN DIAGRAM 1.

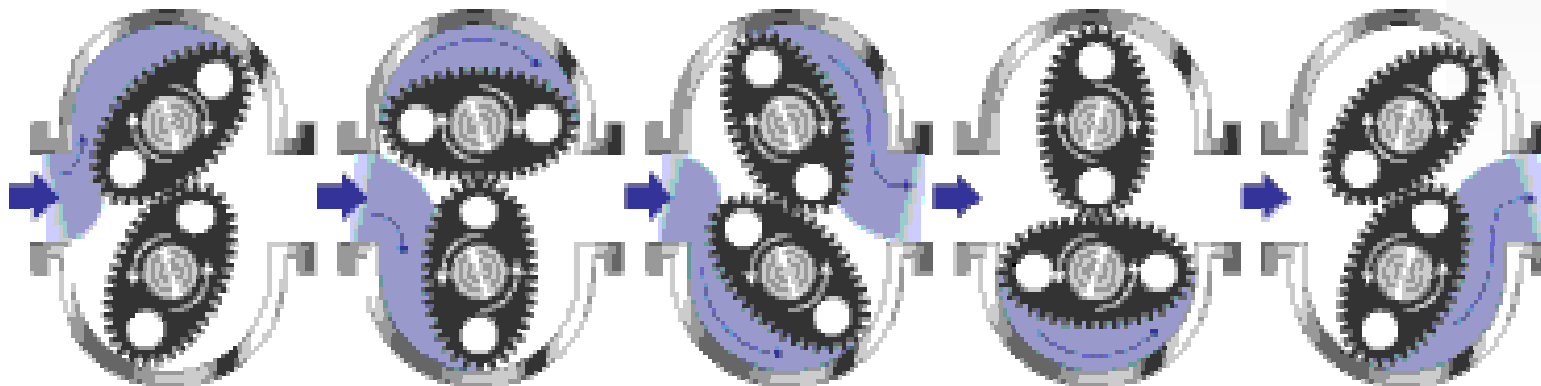


Piston gliding direction:
The piston glides around the control roller like a hula hoop oscillates/spins around the hooper in a circular motion.

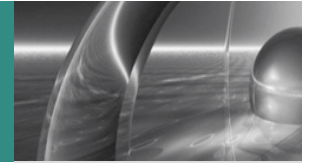


Positive Displacement

❖ Oval Gear



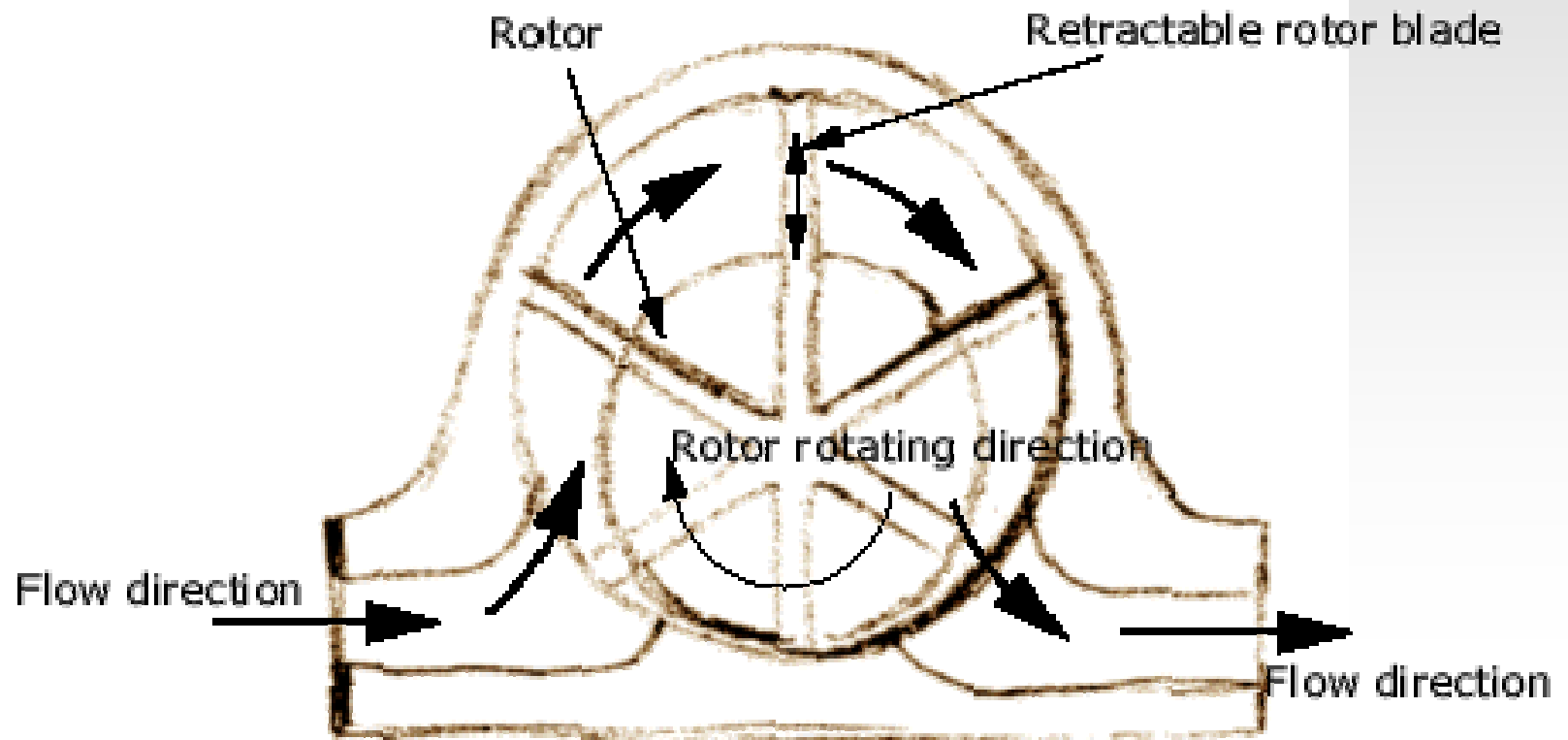
Positive Displacement



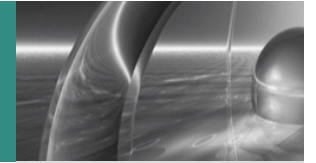
❖ Other Positive Displacement Meters:

- Rotating Valve

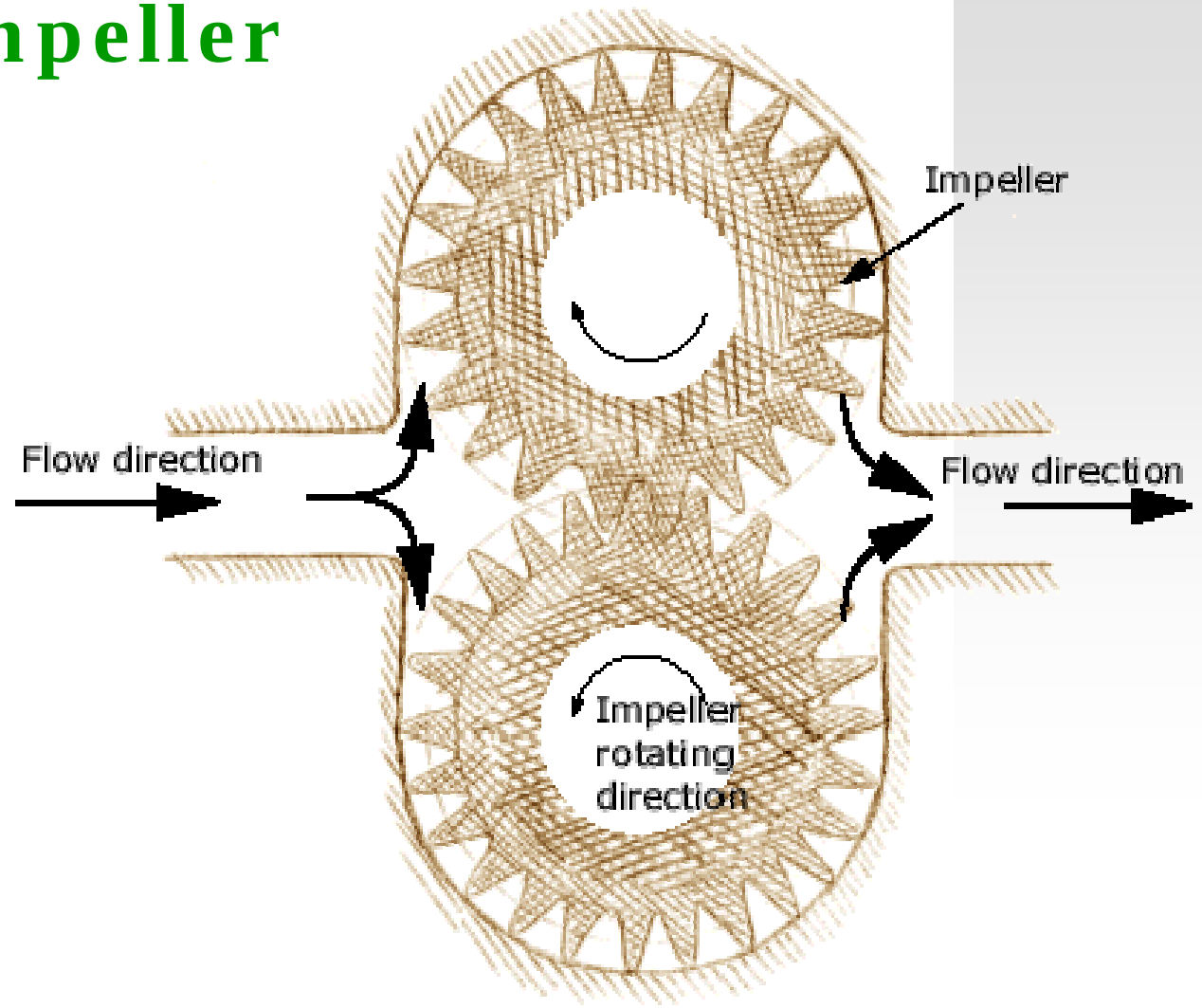
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Positive Displacement

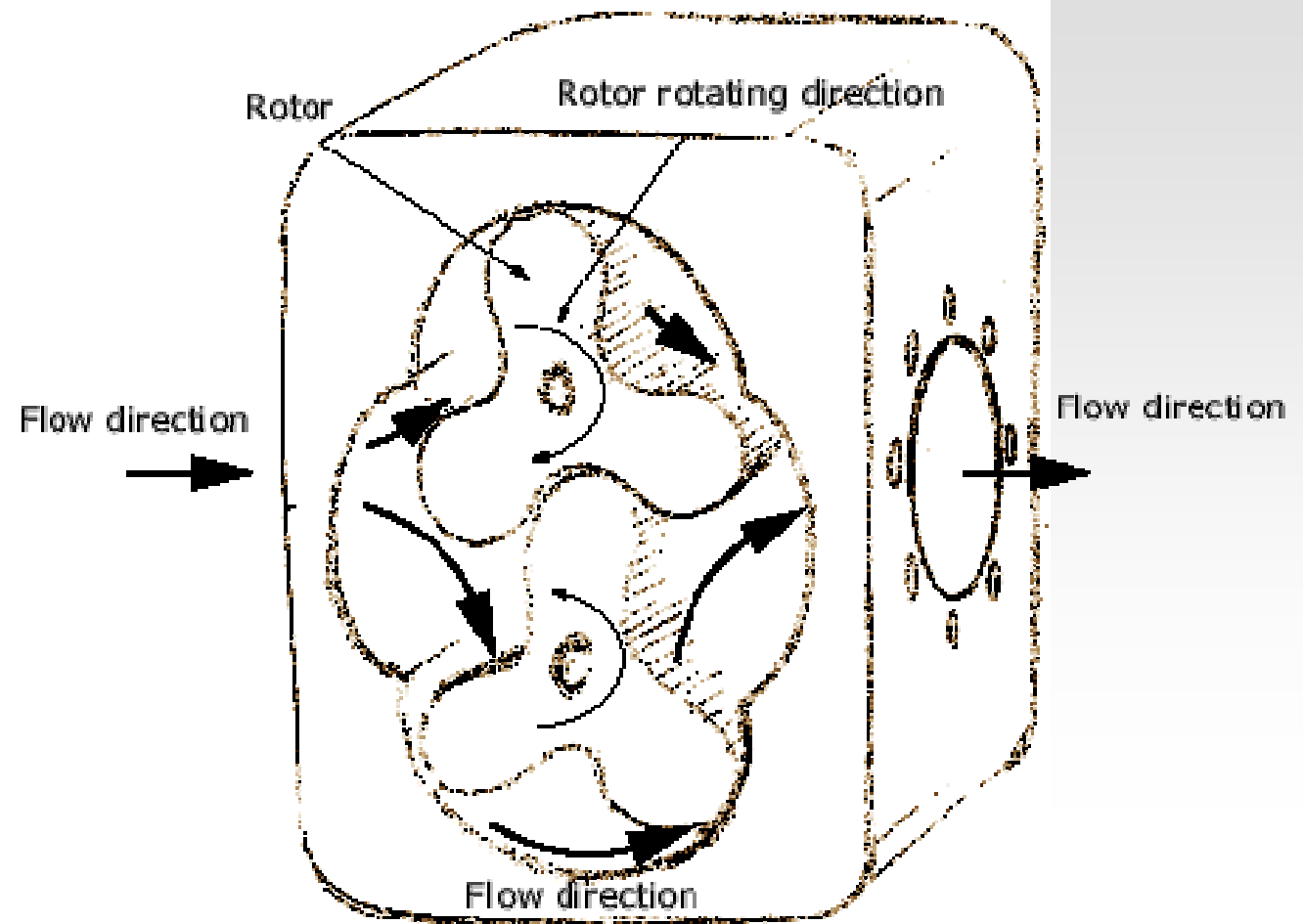


•Rotating Impeller



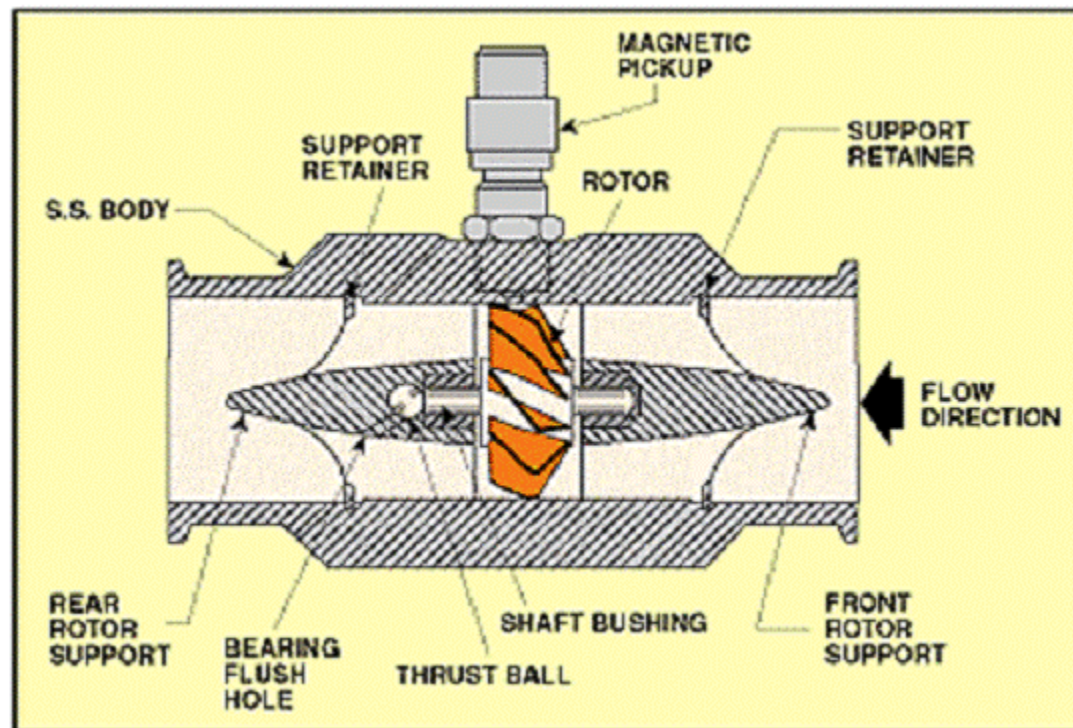
Positive Displacement

❖ Birotor



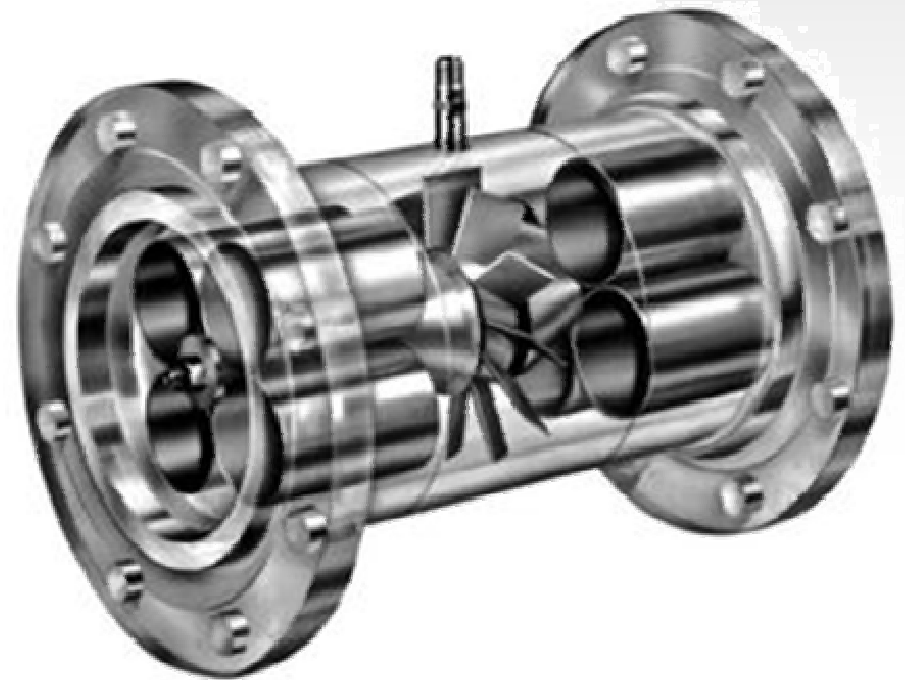
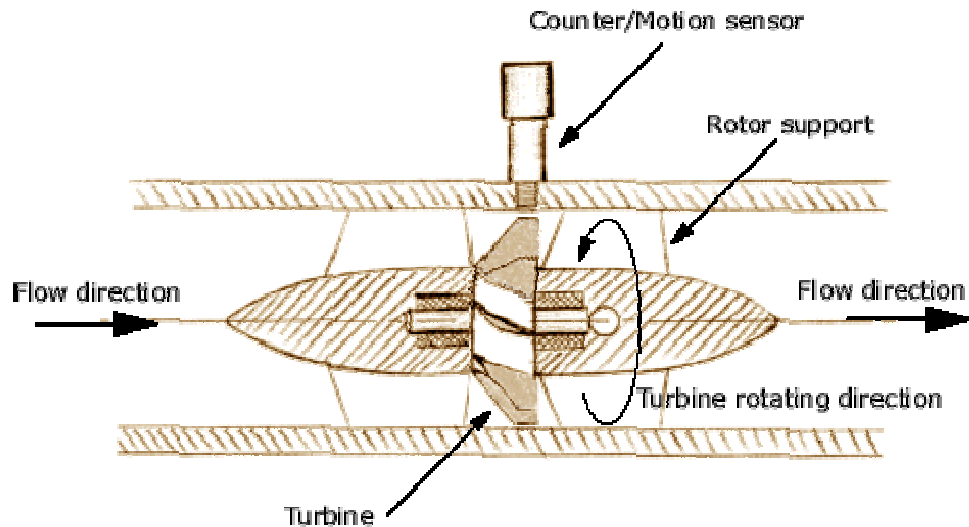
Rotary Inferential Meters

- ❖ This group of meters are basically all small hydraulic turbines running at practically no load. they all have runner or rotary element whose speed is proportional to flow rate.



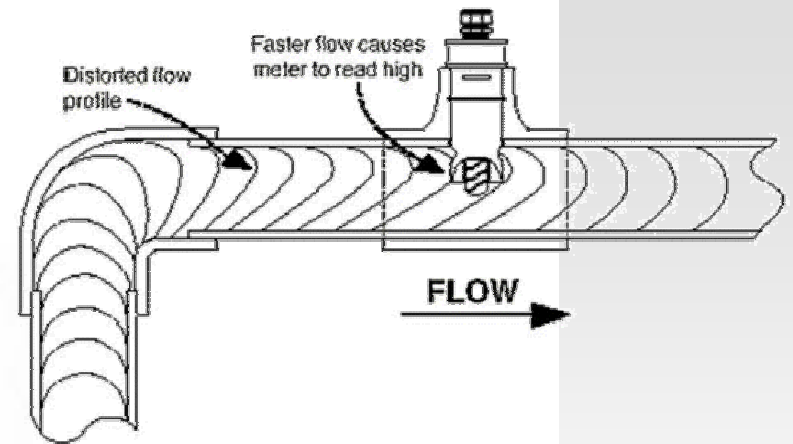
Rotary Inferential Meters

❖ Turbine Flow Meter



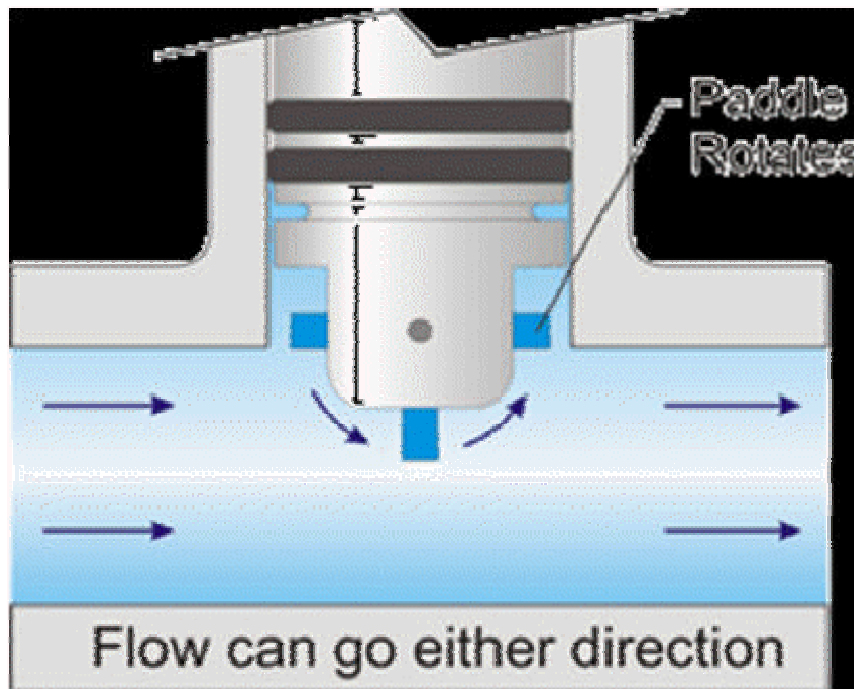
Rotary Inferential Meters

Insertion Type

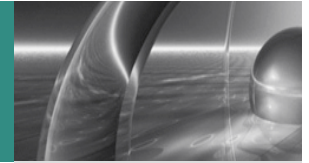


Rotary Inferential Meters

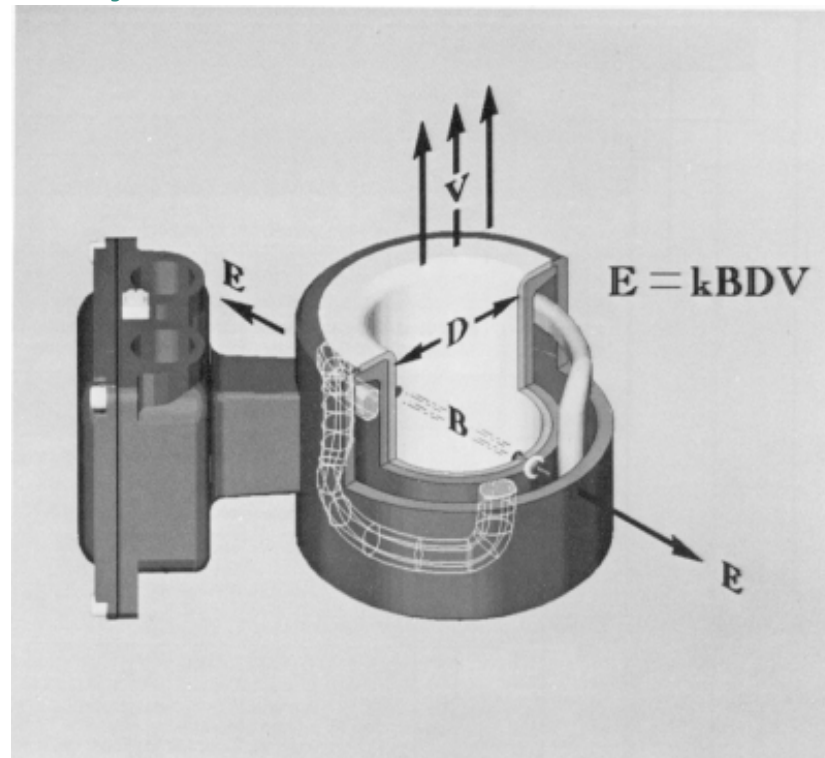
❖ Paddle Wheel



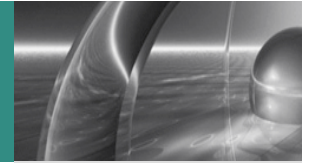
Electromagnetic Flow Meter



- ❖ Magnetic flowmeters use Faraday's Law of Electromagnetic Induction to determine the flow of liquid in a pipe. In a magnetic flowmeter, a magnetic field is generated and channeled into the liquid flowing through the pipe. Following Faraday's Law, flow of a conductive liquid through the magnetic field will cause a voltage signal to be sensed by electrodes located on the flow tube walls.



Electromagnetic Flow Meter



❖ Advantages:

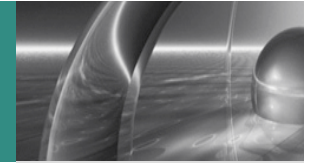
- Minimum obstruction in the flow path yields minimum pressure drop
- Low maintenance cost because of no moving parts
- High linearity
- Two and multi beam models have higher accuracy than other comparably priced flowmeters
- Can be used in hazardous environments or measure corrosive or slurry fluid flow

❖ Disadvantage:

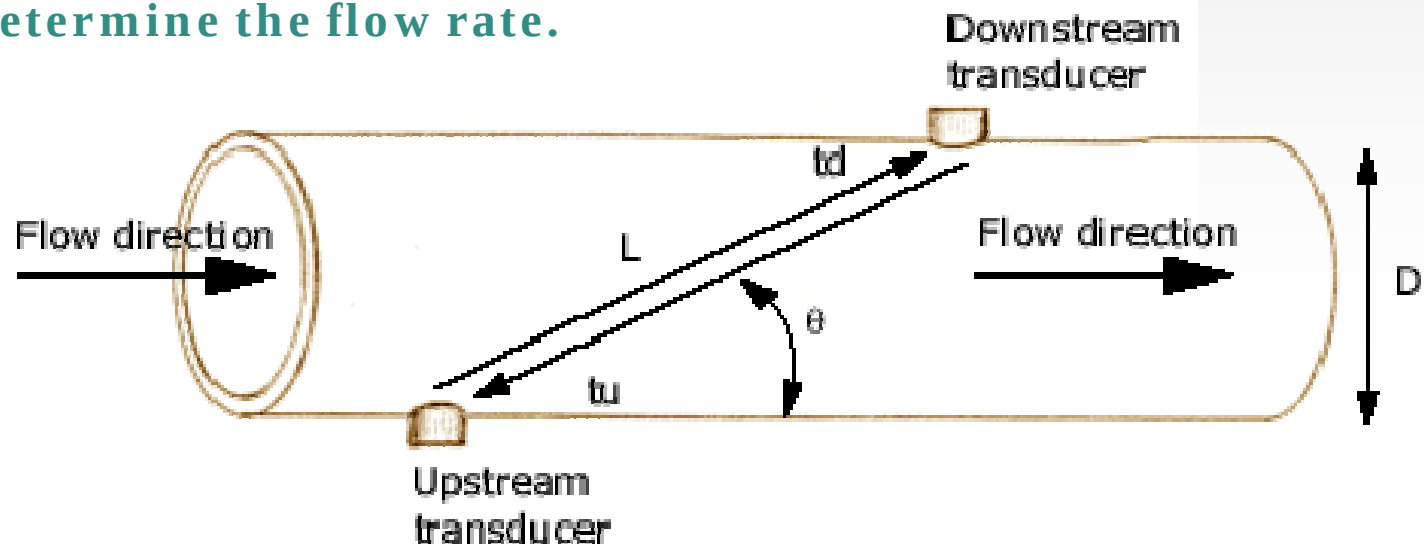
- Requires electrical conductivity of fluid



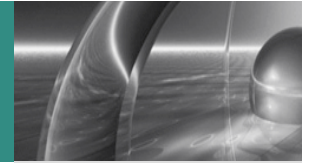
Ultrasonic Flow Meters



- ❖ Transit time ultrasonic flowmeters send and receive ultrasonic waves between transducers in both the upstream and downstream directions in the pipe. At no flow conditions, it takes the same time to travel upstream and downstream between the transducers. Under flowing conditions, the upstream wave will travel slower and take more time than the (faster) downstream wave. When the fluid moves faster, the difference between the upstream and downstream times increases linearly. The electronic transmitter processes upstream and downstream times to determine the flow rate.



Ultrasonic Flow Meters



❖ Advantages:

- No obstruction in the flow path, no pressure drop
- No moving parts, low maintenance cost
- Multi-path models have higher accuracy for wider ranges of Reynolds number
- Can be used in corrosive or slurry fluid flow
- Portable models available for field analysis and diagnosis

❖ Disadvantages:

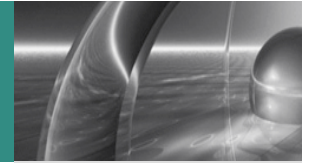
- Higher initial set up cost
- Single path models may not be suitable for flow velocities that vary over a wide range of Reynolds number



Key Features Of Design



Check List Of Design



❖ **Fluid Properties:**

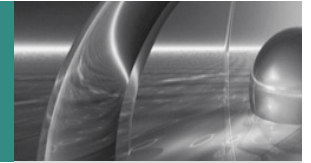
- Liquid or Gas
- Temperature and Pressure
- Density
- Viscosity
- Chemical Properties

❖ **Performance Consideration:**

- Accuracy
- Repeatability
- Linearity
- Pressure Drop
- Output Signal Characteristics
- Response Time



Check List Of Design



❖ **Economic Consideration:**

- **Cost Of Owner Ship (i.e. purchase , installation , operation , maintenance , calibration , meter life , sparse)**
- **Pressure Loss**

❖ **Environmental Considerations:**

- **Ambient Temperature Effect**
- **Atmosphere Of Installation (indoors , Outdoors , corrosive , hot , cold , etc)**
- **Humidity Effect**
- **Safety Factors**
- **Location Of Flow Measurement Device And Piping System (force main , sewer , manhole , channel , or treatment unit)**
- **Type of Secondary Element (level sensor , pressure sensor , transmitters and recorders)**
- **Space Limitations and Size Of Device**
- **Compatibility With Other Flow Measurement Devices If Already in operation at the existing portion of the treatment facility**



Market

❖ **FISHER ROSEMOUNT (Emerson)**

❖ **YAMATAKE**

❖ **FOXBORO**

❖ **ABB**

❖ **HIMA**

❖ **ENDRESS & HAUSER**

❖ **SAMSON**

❑ **SANGAN SANAT**

❑ **AZMOON MOTAMAM**

Irosco

Faranegar Sanat

Shuttle Pars

Fimco

Hanif

PATSA

Tech control





Thank You !